Advisory Circular

Subject: INSTALLATION OF THERMAL/ACOUSTIC INSULATION FOR BURNTHROUGH PROTECTION	**Date:** 1/17/06 **Initiated by:** ANM-115	**AC No:** 25.856-2

1. PURPOSE. This advisory circular (AC) provides guidance for the test method to determine burnthrough resistance of thermal/acoustic insulation materials installed in transport category airplanes. This guidance applies to airplanes required to comply with § 25.856 and part VII of Appendix F to 14 CFR part 25.

2. APPLICABILITY.

a. The guidance provided in this document is directed to airplane manufacturers, modifiers, foreign regulatory authorities, and Federal Aviation Administration (FAA) transport airplane type certification engineers and their designees.

b. This material is neither mandatory nor regulatory in nature and does not constitute a regulation. It describes acceptable means, but not the only means, for demonstrating compliance with the applicable regulations. The FAA will consider other methods of demonstrating compliance that an applicant may elect to present. While these guidelines are not mandatory, they are derived from extensive FAA and industry experience in determining compliance with the relevant regulations. On the other hand, if we become aware of circumstances that convince us that following this AC would not result in compliance with the applicable regulations, we will not be bound by the terms of this AC, and we may require additional substantiation or design changes as a basis for finding compliance.

c. This material does not change, create any additional, authorize changes in, or permit deviations from, regulatory requirements.

3. RELATED REGULATIONS AND DOCUMENTS.

a. 14 CFR 25.856 and part VII of Appendix F to 14 CFR part 25.

b. Advisory Circulars (AC) 25.856-1, “Thermal/Acoustic Insulation Flame Propagation Test Method Details.” You can download an electronic copy of AC 25.856-1 from the Internet at http://www.airweb.faa.gov/rgl. You may order a paper copy from the U.S. Department of Transportation, Subsequent Distribution Office, M-30, Ardmore East business Center, 3341 Q 75th Avenue, Landover, MD 20795.

4. BACKGROUND.

a. Accidents have illustrated the threat that exists due to fuel spillage from damaged aircraft fuel tanks that result in pool fires that penetrate into the cabin. Research has shown that the aluminum skin currently in use offers little opportunity to prevent burnthrough. Thermal/acoustic insulation, however, having the appropriate fire resistant properties and installed in a controlled manner, can delay the onset of fire into the cabin for a sufficient length of time to allow passenger evacuation. The installation methods and materials are critical in deriving the benefit of fire resistant thermal/acoustic insulation.

b. Amendment 25-111 (68 FR 45046, July 31, 2003) introduced a new test method and requirement into part 25 that improves the fire penetration resistance of thermal/acoustic insulation. This AC provides guidance on the installation details and techniques that have been found to be acceptable to realize the full potential of materials having satisfactory fire-resistant properties. Since the primary threat from pool fires is to the lower half of the fuselage, the regulation applies only to the lower half (see paragraph 6e of this AC). The installation criteria specified in this AC are applicable to thermal/acoustic insulation installed in that area; however, use of similar techniques throughout the airplane may be desirable for consistency.

c. The guidance in this AC is mainly directed at installation systems consisting of a batting encapsulated by a moisture barrier. The insulation is installed by mechanically fixing it to the airframe structure. The guidance in this AC may be inappropriate or not applicable to certain materials and/or installation systems. Where doubt exists as to the relevance of the criteria specified to any particular installation system, perform testing on a burnthrough test rig configured to be representative of a fuselage exposed to a pool fire. See paragraph 7 of this AC for further discussion of this issue.

5. EXPLANATION OF TERMS.

a. Burnthrough. The penetration of an external fire into the airplane cabin, typically through the airplane skin, insulation, and sidewall or floor structure. For the purposes of the test, a breach of 0.25” or more in diameter is considered burnthrough.

b. <u>Overlap</u>. The length of insulation material that presents a double thickness of material either against the airplane skin, for the purposes of joining two bags, or abutting airframe structure other than the fuselage skin (see Figure 1).

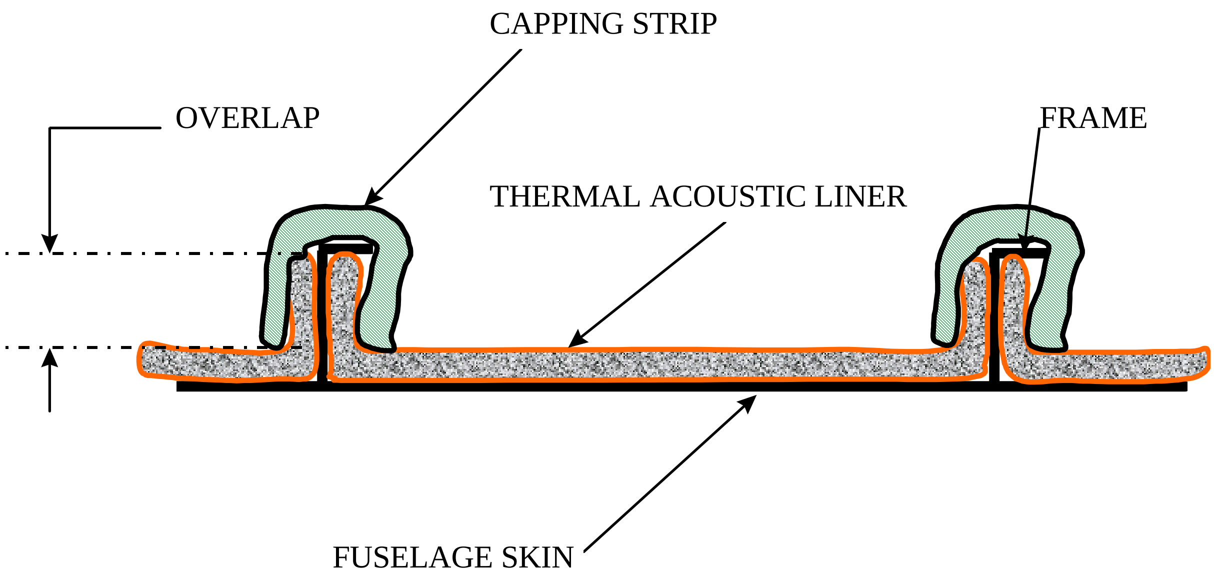

Figure 1. Overlap

c. <u>Pool Fire</u>. An extensive ground fire originating from fuel spillage from damaged airplane fuel tanks.

d. <u>Thermal/Acoustic Liner</u>. Any materials (for example, a blanket) that are used to thermally or acoustically insulate the interior of the airplane. These materials are installed onto the airplane skin or other structure to form a barrier between the passenger cabin and an external fire. Thermal/acoustic liners consisting of batting encapsulated by a moisture barrier may be known as "bags."

e. <u>Field Blanket</u>: Thermal/acoustic liner positioned between structural members (frames, for example) and typically fastened on the liner's periphery.

f. <u>Lower Half</u>: The area of the fuselage below the horizontal line that bisects the cross section of the fuselage. This may be determined using the height of the fuselage as a basis.

6. INSTALLATION OF THERMAL/ACOUSTIC INSULATION.

a. <u>General</u>. As noted previously, the method of installation is very important in realizing the benefits of improved materials. To date, numerous thermal/acoustic insulation materials have been successfully tested. These materials can be classified into three basic categories: batting systems, barrier systems, and encapsulating systems.

(1) A batting system incorporates a more fire-resistant material to either partially, or fully, replace the industry-standard fiberglass material. In some instances, the system may contain layers of both improved and standard materials.

(2) A barrier system uses a thin, fire-resistant barrier material placed inside the standard fiberglass blanket. This barrier can be placed outboard of the insulation, inboard of it, or sandwiched between layers.

(3) An encapsulating system incorporates a fire-resistant film cover material surrounding the batting that also acts as a fire barrier.

> Note: Appendix 1 of this AC contains schematic representations of systems that have been tested using actual airplane structure and satisfy the requirement. These schemes are suitable for demonstration in the test rig, as defined in part VII of Appendix F. Variations from the representations shown in Appendix 1 of this AC that would make the installation more critical (for example, increased fastener pitch) should be assessed using the fixture modification as shown in paragraph 7 of this AC.

b. Overlap.

(1) Overlap at Frames. Any gaps in the insulation material provide a possible penetration route for fire to enter the cabin. Testing has shown that it is necessary to install insulation bags at frames so they completely cover the frames. Where this is achieved with more than one blanket, a minimum overlap of two inches should be used. Use the total frame height for frames smaller than two inches. Overlaps greater than two inches will provide greater protection times. Ideally, a single insulation blanket would extend over the frame. See Figures 2 and 3. In those cases where there is cargo compartment liner meeting the requirements of part III of Appendix F, attached to or abutting the inboard cap of the frame, it is not necessary to overlap the insulation on the cap of the frame. See Figure 4.

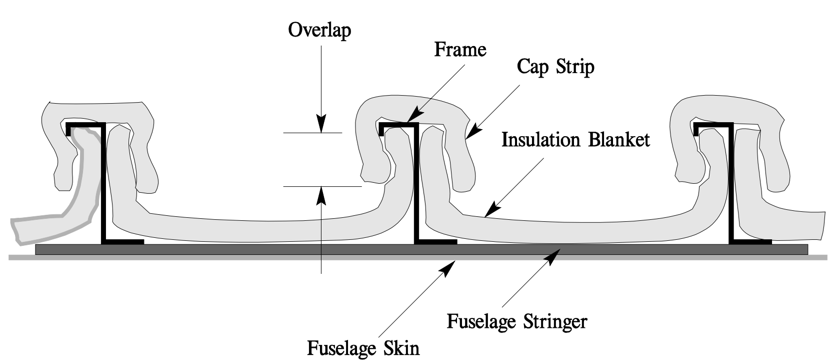

Figure 2. Method of Overlap at Frame

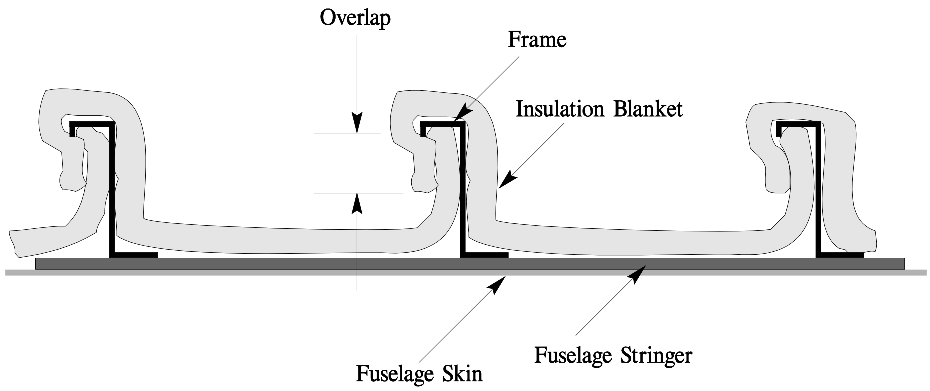

Figure 3. Method of Overlap at Frame

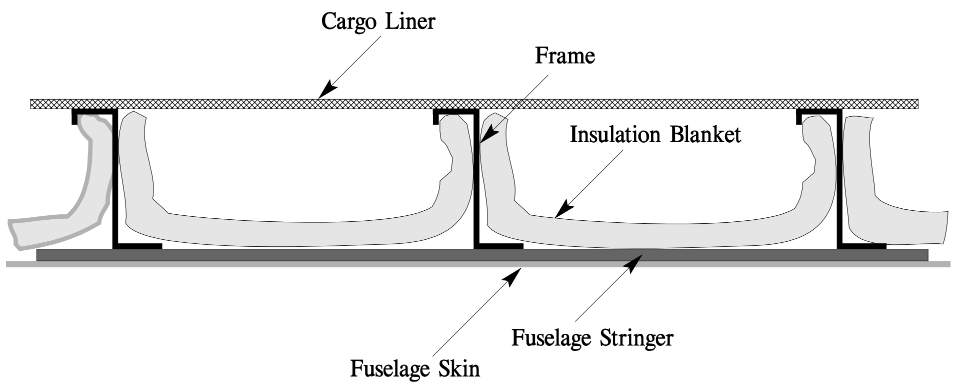

Figure 4. Cargo Liner as Part of Barrier

(2) Overlapping of Insulation Blankets. Joints between insulation blankets other than over frames should also be such that overlap of the blankets is provided. Testing has shown that a minimum of 6 inches of overlap is required in order to achieve satisfactory protection. For some materials, it may be possible to demonstrate that less than 6 inches of overlap is acceptable using the test burner. In that case, changing the burner/test stand relationship, so that the burner flame impinges between two of the frames, and on the overlapped area, is an acceptable method to substantiate a lesser overlap (see paragraph 7c.) Additionally, to reduce potential for fire entry, if the installation considerations permit, blankets should be "shingled" so that the upper blanket overlaps the lower blanket in relation to the fuselage interior. Joints may be secured with a tape or mechanical fasteners that have suitable fire-resistant properties. See Figure 5. Smaller amounts of overlap may be acceptable if the two blankets are fastened together using a fire-resistant fastening method. Typical hook and loop fasteners have not proven to be any more effective in delaying burnthrough than with blankets that are not fastened. Joints between blankets within a frame bay are not recommended where the overlap would be at the extreme bottom of the fuselage.

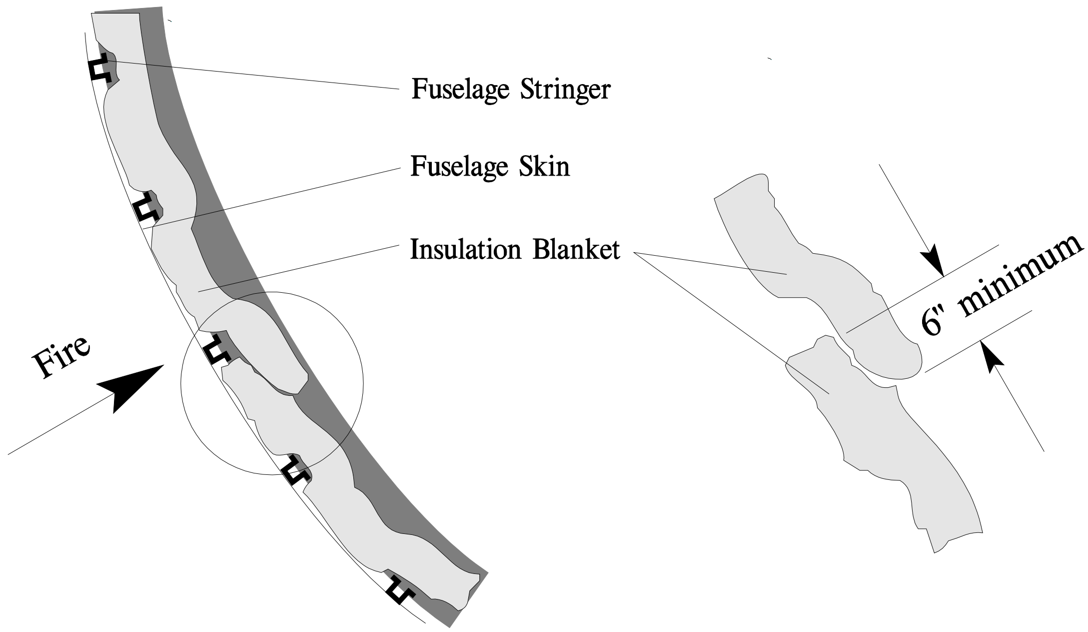

Figure 5. Method of Overlapping

c. Discontinuities.

(1) Terminal blocks, pipe attachments, or any other feature attached to the airplane structure in close proximity to the airplane skin present a possible fire penetration route unless protected. Where practical, the thermal/acoustic liner should be installed so as to minimize the potential for fire penetration. This might be achieved by providing a degree of overlap of the liner, or fabricating the item creating the discontinuity in the liner out of material that is fire resistant.

(2) Certain discontinuities are unavoidable: for example, where essential systems must go from the outboard to the inboard side of the insulation material, and such systems cannot practically be constructed of fire-resistant material themselves. Since the regulation does not mandate installation of thermal/acoustic insulation, such discontinuities cannot be prohibited, although their occurrences should be minimized. Such discontinuities need not be considered in the test samples. The rule however *does* require consideration of the installation methodology, so discontinuities in the insulation would not be acceptable if they are *caused by* the installation method.

d. Attachment Methods.

(1) General.

(a) Penetration of thermal/acoustic liners should be avoided wherever possible since this results in a possible fire entry point. Attachment methods that do not penetrate the liners, such as over-frame attachments, are preferred, and carry fewer constraints on the type of material they may be constructed from.

(b) Attachment methods that provide good mechanical retention of thermal/acoustic liners are more likely to provide good burnthrough protection, provided they also have the other physical and material properties defined in this AC.

(2) Through-Frame Attachments. Attachment methods, or fasteners, that penetrate the insulation bag and frame should be metallic (that is, aluminum, or material with an equivalent melting point). Attachment point spacing (pitch) along the frame should be a maximum of 14 inches. Testing has shown that a pitch of 14 inches will provide acceptable fire penetration resistance. Conversely, testing has also shown that a pitch of less than 14 inches does not provide significantly enhanced protection. See Figures 6 and 7.

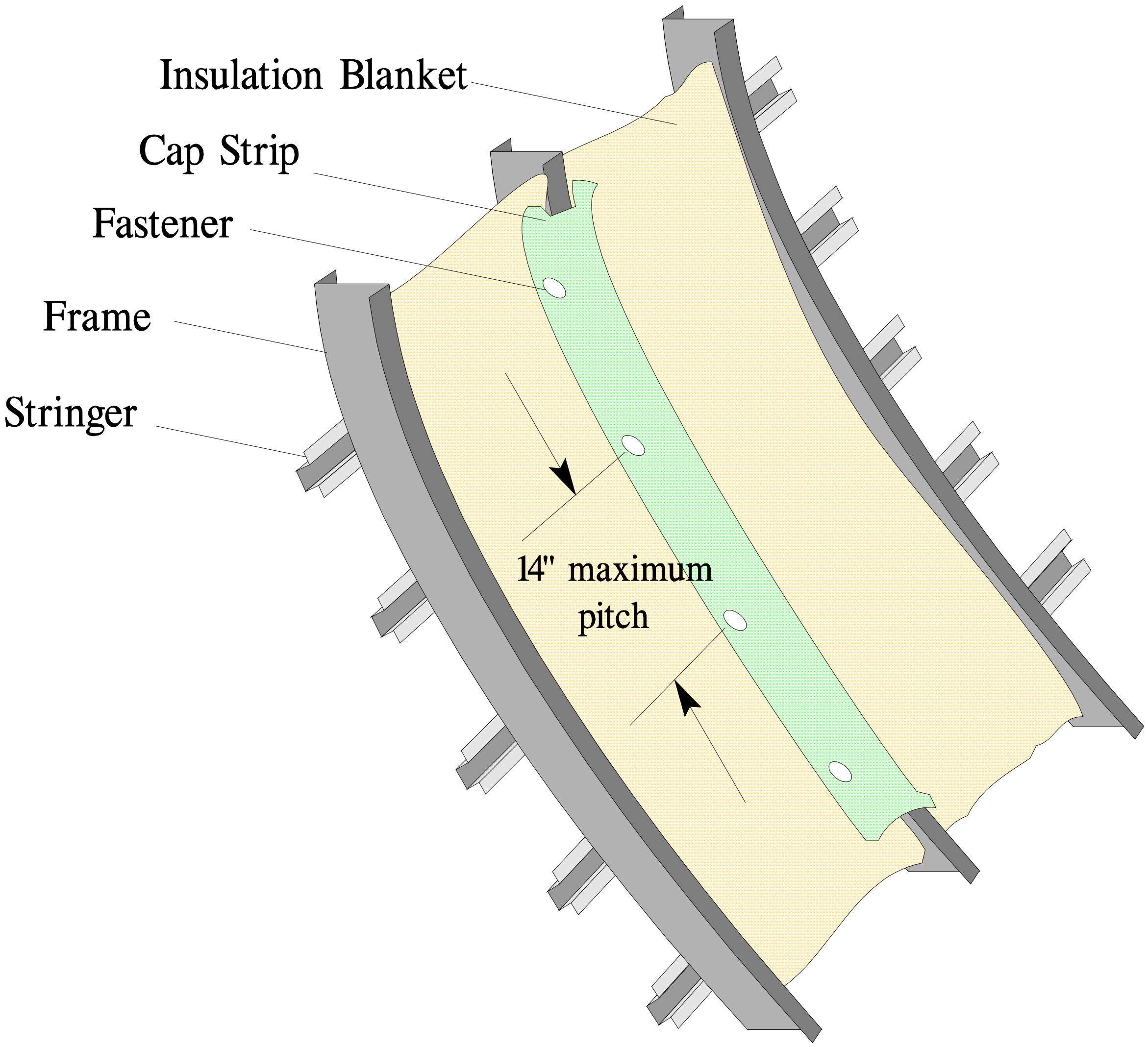

Figure 6. Frequency of Attachment (Pitch)

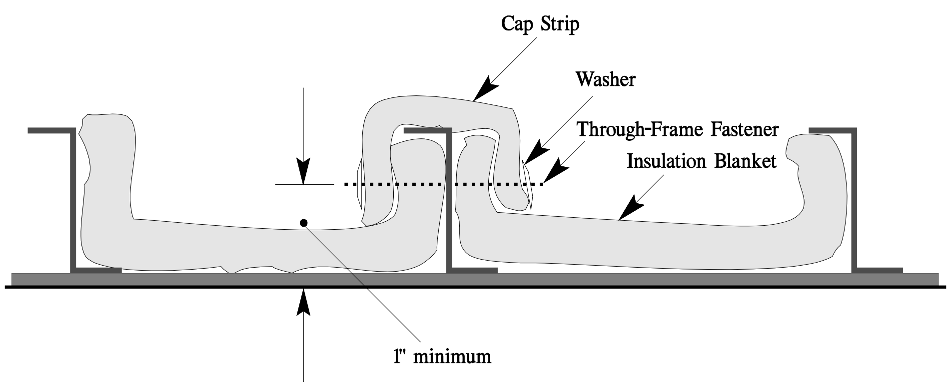

Figure 7. Through-Frame Fastener

Through-frame attachments should be installed as far away from the fuselage skin as practical. The space between the fuselage skin and the through-frame attachment should be a minimum of 1 inch. Where it is not practical to achieve this amount of space, consideration should be given to alternative attachment methods (for example, over-frame attachments). See Figure 8. Note that this AC does not address structural ramifications associated with attachments that penetrate the airframe.

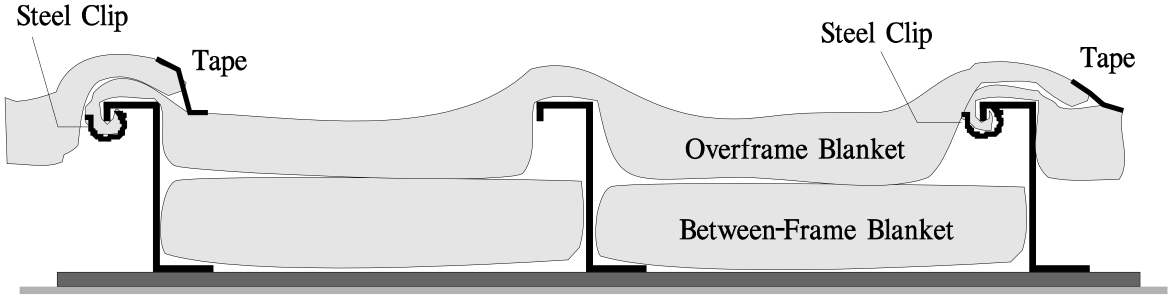

Figure 8. Over frame Attachment

(3) Over-frame Attachments. Fasteners that do not penetrate the frame, but provide attachment for the insulation bags by clipping them over the top of the frame, have been found to be satisfactory in terms of preventing fire penetration at the joints. The design and material of such clips and their pitch should provide good retention of the thermal/acoustic liners. A maximum pitch of 14 inches for over-frame attachments has been demonstrated to be acceptable for compliance. See Figures 8 and 9.

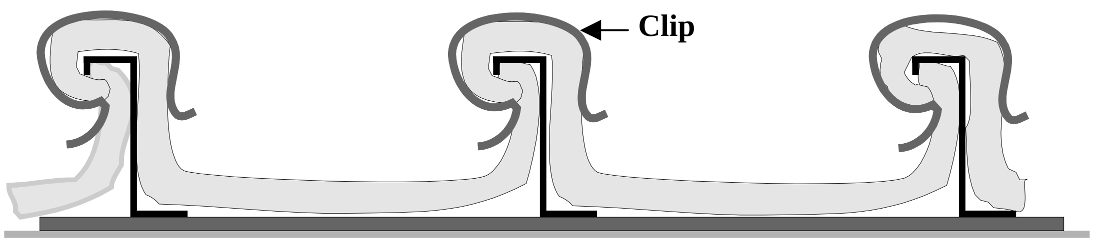

Figure 9. Over Frame Blanket Installation

(4) Stringer Attachments. Fasteners that penetrate the thermal/acoustic liner and attach it to stringers should be metallic (that is, aluminum, or material with an equivalent melting point). See Figure 10.

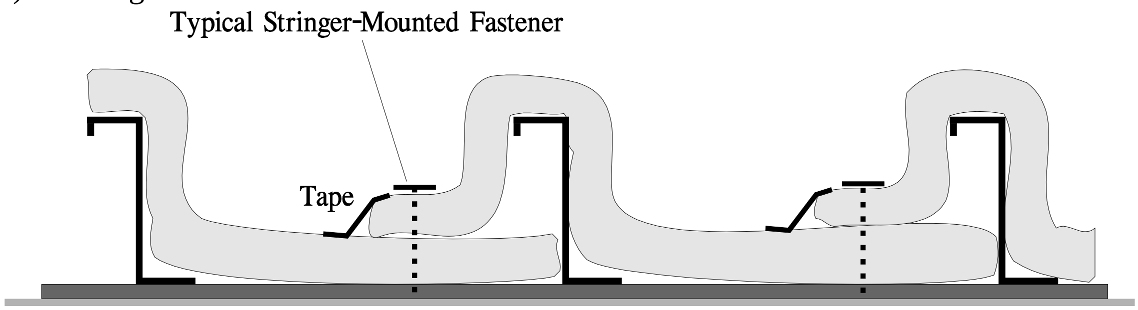

Figure 10. Stringer-Mounted Fastener

e. Lower Half. Section 25.856 requires that thermal/acoustic insulation installed in the lower half of the fuselage comply with the test requirements of part VII of Appendix F for flame penetration resistance. As discussed in the preamble to Amendment 25-111, the requirement applies to thermal/acoustic insulation installed against the fuselage skin, or in another manner that provides burnthrough protection. The regulation *does not* apply to insulation on ducts installed in the lower half of the fuselage. The requirement *does* apply to insulation installed on the floor panels, if there was no insulation installed on the outer fuselage in the lower half. The requirement does *not* apply to the floor panels if insulation were installed in both places. It is the intent of the regulation that the occupied areas of the airplane have greater fire protection through enhanced burnthrough resistance of the lower half of the fuselage, using installed insulation (see Figure 11).

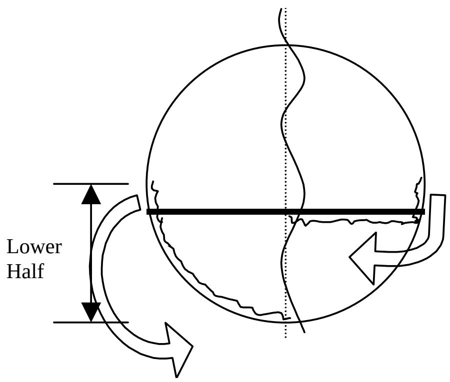

Figure 11. Shows two approaches to insulating the lower half of the airplane. On the left, the insulation is installed on the fuselage skin; on the right, the insulation is installed along the floor. Either approach would have to comply with the requirement. But if insulation was installed in both places, it would only have to comply in one place.

Figure 11. Insulation on Lower Half of Airplane

7. OTHER THERMAL/ACOUSTIC INSULATION CONCEPTS. The oil burner test described in part VII of Appendix F is intended to represent the temperature and heat flux approximately equivalent to a post-crash fire. The scale of the test method does not replicate the scale of an actual fire. In addition, the test stand incorporates steel components to facilitate repeated testing, and to eliminate small structural details from the test setup. When materials or installation designs other than those discussed in section 6 are used, the standard test apparatus may not be appropriate. It is not necessarily adequate to simply incorporate a novel feature or design concept into the test sample to verify its acceptability. In some cases, larger scale testing will be required to support development of special conditions. In other cases, the test burner might be acceptable, but the test stand might require modification (for example, substitution of aluminum frames for the steel frames) in order to produce valid results.

a. Other Material Types. As previously noted, this AC assumes one of three methods of providing a fire barrier with respect to substantiation of installation details. Other methods, such as foam blocks or spray-on applications, have not been investigated to the same extent; and reliable substantiation methods for installation have not been developed. Conduct realistic testing on these types of materials to establish guidance for their installation. The general principles of avoiding discontinuities and penetrations are expected to be valid, regardless of the type of insulation employed. Some specifics, for example the amount of overlap, are likely to be different.

b. Other Means of Attachment. Means of attachment that vary significantly from those described in this AC will require substantiation with more representative installation fixturing. For example, a hook and loop type attachment would require substantiation by test, but could probably be accomplished using the test burner, with appropriate modification to the frames and stringers.

c. Modification of the Test Fixture.

(1) If the test fixture needs to be modified in order to address material and/or installation schemes not anticipated by the rule, the existing vertical steel frame is replaced with an aluminum frame. Similarly, two of the steel horizontal stringers are replaced with aluminum stringers (see Figure 12). This methodology allows the aluminum members to melt and fail with the realism of an actual aircraft fuselage during a post-crash fire scenario. Under these conditions, not only are the blanket materials being tested, but the ability of the insulation *system* for preventing flame penetration is examined. Such a test also assesses details of the system used to attach the insulation to the frame, including clips, tape, hook and loop, etc. Since there are numerous combinations of frame geometry, material thickness etc., the applicant should propose a critical case for substantiation of use on the airplane, if this method of testing is necessary.

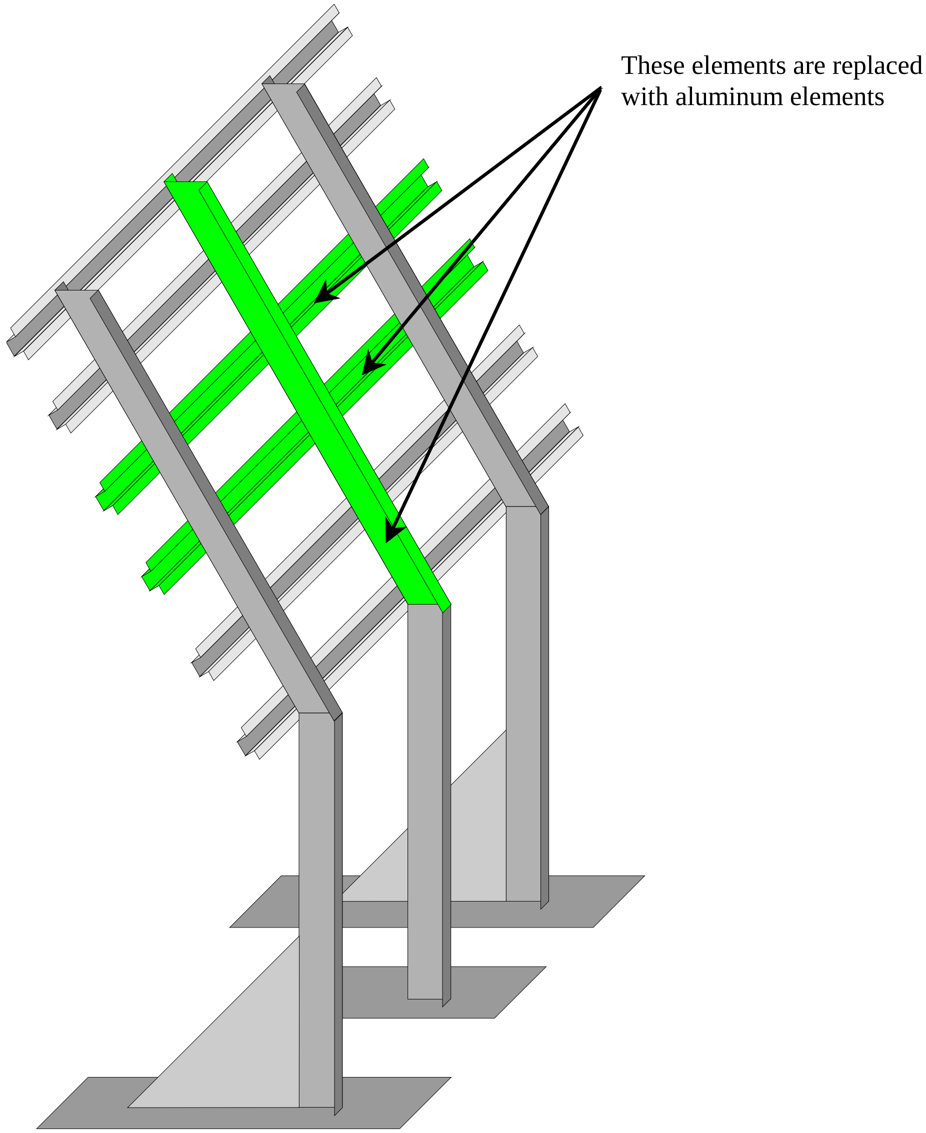

Figure 12. Modified Test Fixture Incorporating Aluminum Components

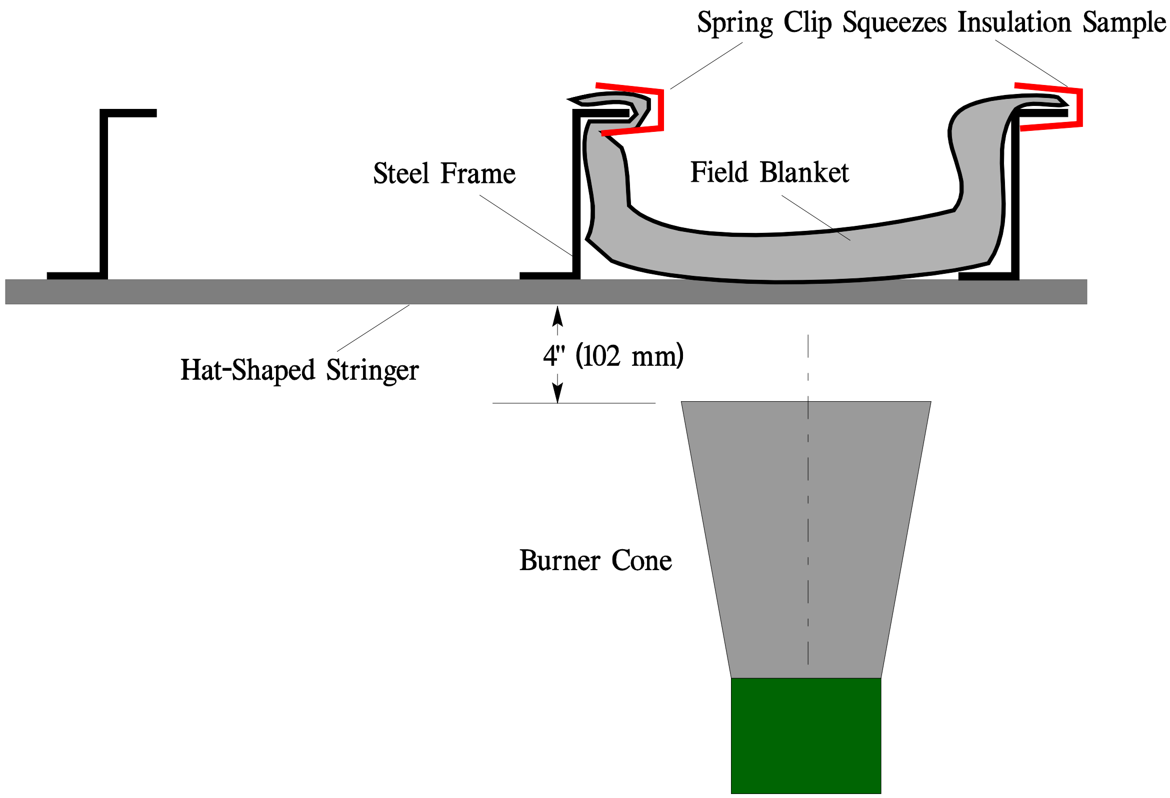

Figure 13. Apparatus Configuration for Testing Overlap

(2) To evaluate an overlap arrangement using less than 6 inches of overlap, both the test stand and its relationship to the burner need to be changed. Figure 13 illustrates the arrangement, which involves moving the burner (or stand) so that the burner flame impinges directly between two frames. In addition, the third stringer from the bottom (i.e., in line with the center line of the burner) is removed and the exposed seam of the overlap is positioned at this point (Figure 14). For this configuration, only physical burnthrough is assessed (no heat flux measurement is required). This is because the geometry no longer represents the standard, and the heat flux measured on the back side would not be comparable to the standard. In addition, the basic material will be qualified in the standard configuration, and that will include assessment of the back side heat flux. It is acceptable to either leave the other frame bay empty, or install a complying material in the standard manner.

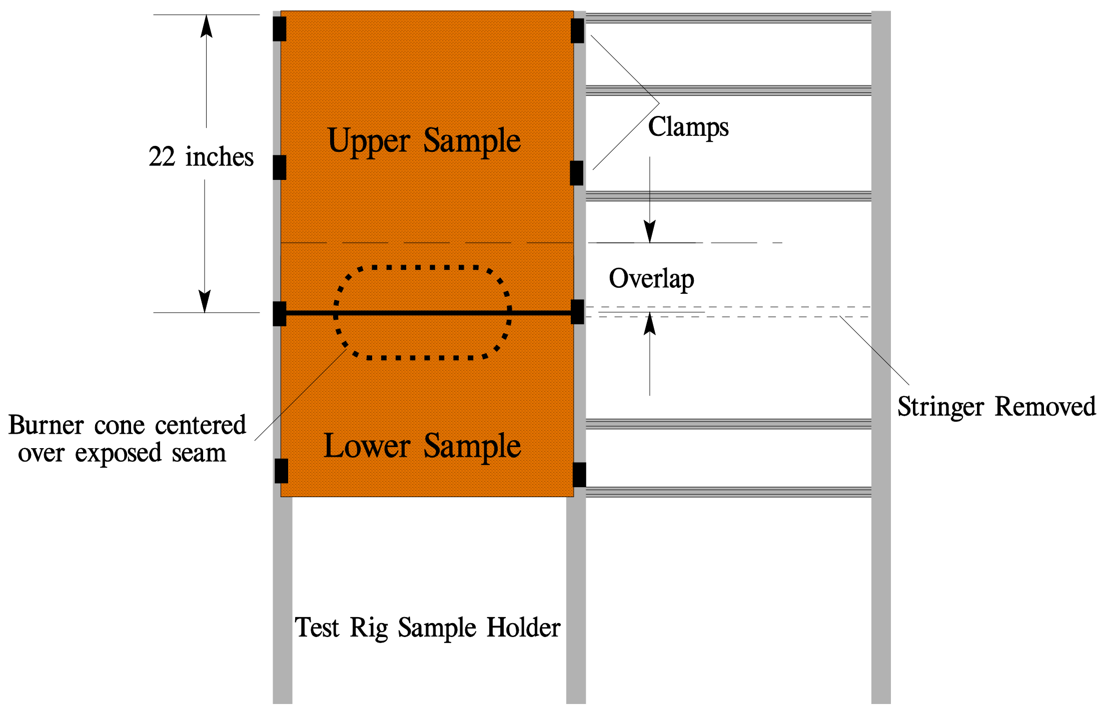

Figure 14. Test Specimen Configuration for Testing Overlap

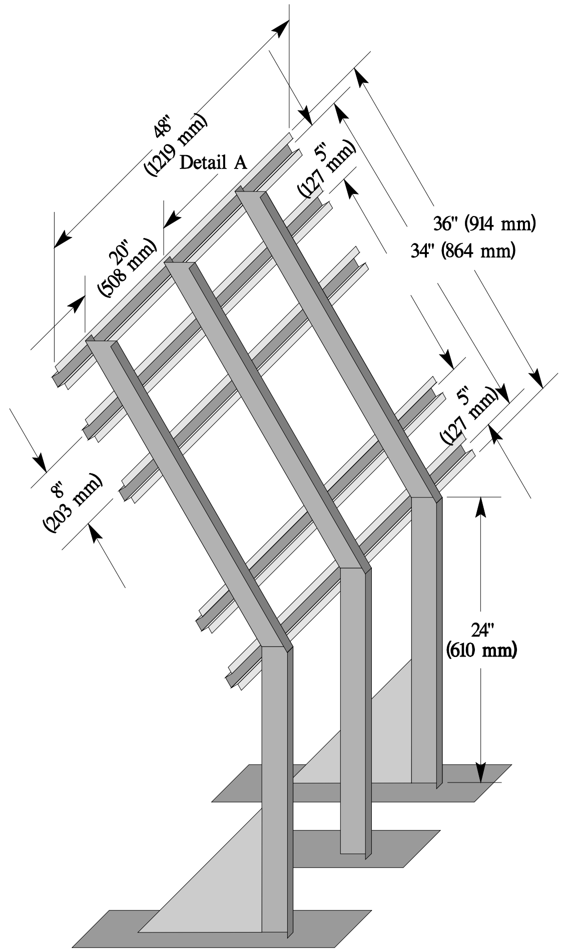

Figure 15. Modified Apparatus for Testing Overlap

8. TEST CONDITION DETAILS.

a. Research has shown that laboratory test conditions can have an influence on test results. In particular, room temperature can affect the calibration, which will, in turn, influence the test results in certain cases. Maintaining consistent environmental conditions, especially between calibration and testing, improves the consistency and reliability of the test results.

b. In addition to the calibration procedures described in part VII of Appendix F, it is useful to periodically "map" the heat flux of the burner over a larger area than is typically encompassed by the calibration measurement. Since each burner will have its own signature heat flux map, the important consideration is consistency; that is, a given burner should maintain approximately the same heat flux map over time.

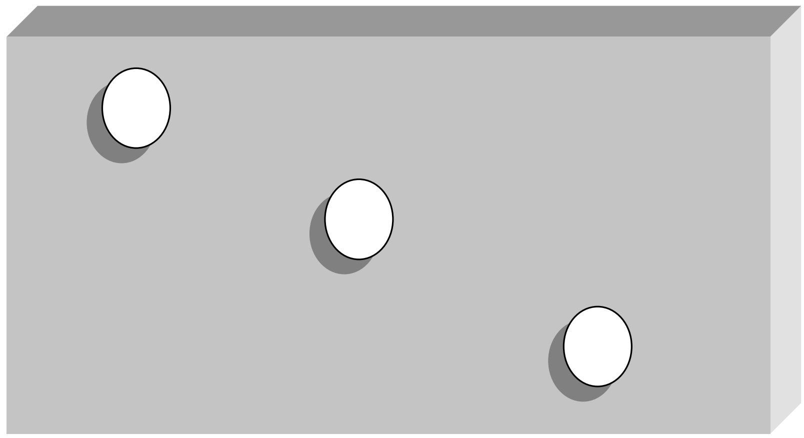

Figure 16. Heat Flux Mapping Fixture

Lab F, New Mapping Procedure w/Intake Duct, 2150 Ft/min

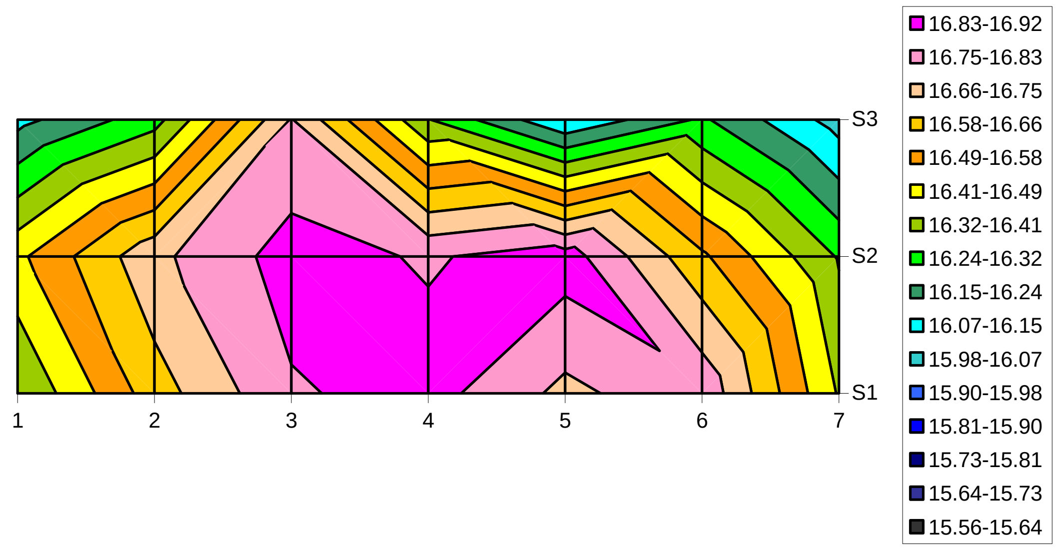

Figure 17. Example of Heat Flux Map

c. The insulation film on each test blanket should have two small slits cut on the back side (away from the flame) to allow combustion gases to escape. This prevents the test blankets from "ballooning," which can alter test results. It is recommended that the 2-inch slits be cut into each blanket, far enough away from the center vertical frame so as not to influence test results. The ballooning phenomenon is not an issue in an actual airplane, because the airplane contains continuous structures and heat transfer mechanisms not present in the test fixture. Therefore, use of slits in the actual installation is not required.

d. Fuel Nozzle: Part VII of Appendix F references a fuel nozzle by model. Due to manufacturing changes, this specific nozzle may not be available. In addition, unless the nozzle is identified as "F-80" it may not match the original specification, and is not recommended. Experience has shown that a 6.5 gallons per hour (gph) 80 degree, PL "F-80" nozzle, with the fuel pressure adjusted to produce the required 6 gph (approximately 85 pounds per square inch), will produce satisfactory results. The actual flow rate should be verified any time the nozzle is changed, even if the nozzles are the same model. Note that the rotational position of the nozzle, independent of the stator position, can influence the heat flux measurement. To facilitate calibration it is useful to document the nozzle position.

e. Burner casting. There are two main types of burner castings commonly in use. These are known as 'socket' and 'flange,' descriptors for the way the draft tube fits into the housing. Experience has shown that the socket type burners tend to produce somewhat higher velocity exit airflow for the same calibration settings. This can result in conservative test results.

f. Airflow through the burner is of critical importance. Ideally, air should only enter and leave the burner through the air inlet and outlet respectively. The burner housing and any other potential sources of air leaks should be sealed. In addition to measuring the airflow into the burner, it may also be useful to measure the airflow out of the burner. This helps confirm consistency of performance and accuracy of the measurements. Variations in airflow can greatly influence the test results, with all other parameters being equal. For this reason, regularly calibrate the air velocity meter. As with heat flux, it may be useful to periodically map the airflow out of the burner cone to monitor consistency of performance.

g. Stators.

(1) The burner should have a stator at the exit of the draft tube. A Monarch F-124 stator is recommended to produce the most consistent results.

(2) Part VII of Appendix F, calls for an internal stator inside the draft tube. A Monarch H215 stator is recommended to produce the most consistent results. However, there are slight variations in the casting for that stator that may make it necessary to modify the stator in order to achieve calibration. Such modifications consist of surface treatment to the stator vanes and have the effect of altering the airflow so that the heat flux measurement can be achieved at the specified location. These modifications do not change the intensity of the burner flame, but are a calibration aide.

h. Igniters. The length of the igniters is not specified in Appendix F. Experience has shown, however, that the igniter's overall length should be as shown in Figure 18.

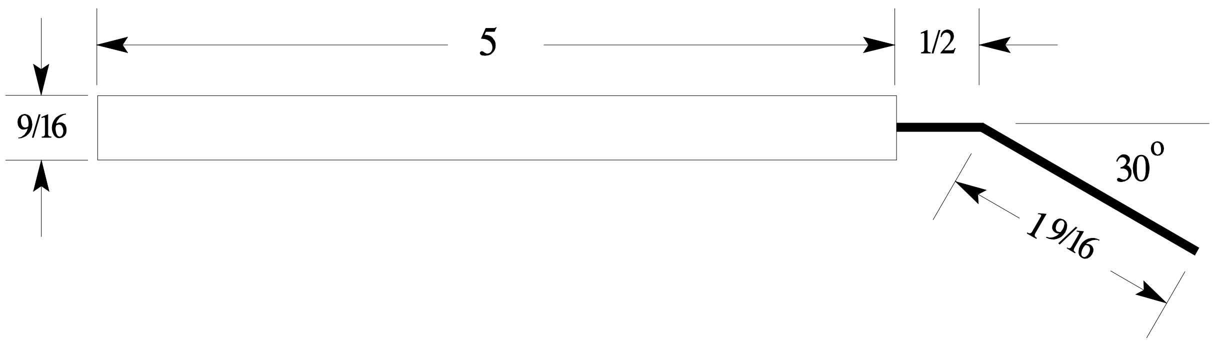

Figure 18. Igniter Geometry

i. Test specimen mounting frame. The center vertical frame can become distorted from repeated exposure to the test burner. Deviations from true of more than +/- 0.25" should be corrected to avoid affecting test results. Note that the gauge of the center vertical frame is heavier than the frames on the sides.

Signed by Ali Bahrami
Ali Bahrami
Manager, Transport Airplane Directorate
Aircraft Certification Service

Appendix 1

Acceptable Installation Approaches

1.	Batting Systems

Figures 1-3

2.	Barrier Systems

Figures 4-8

3.	Encapsulating Systems

Figures 9-10

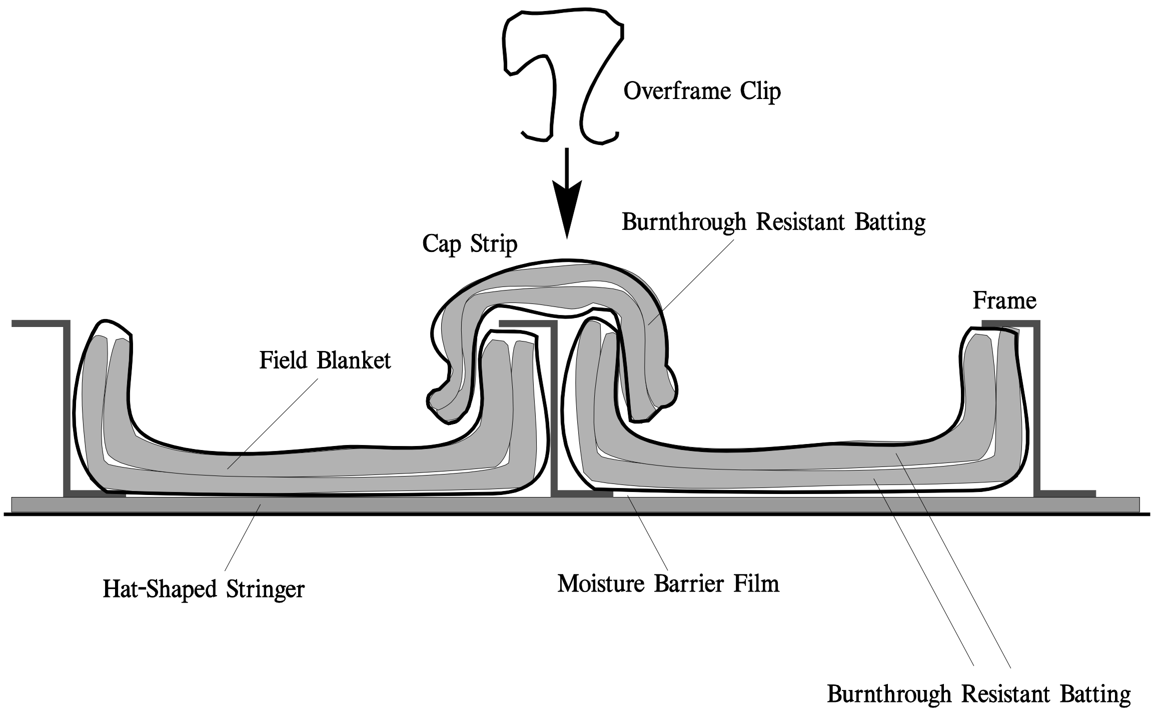

Figure 1-1. Conventional Replacement Batting System

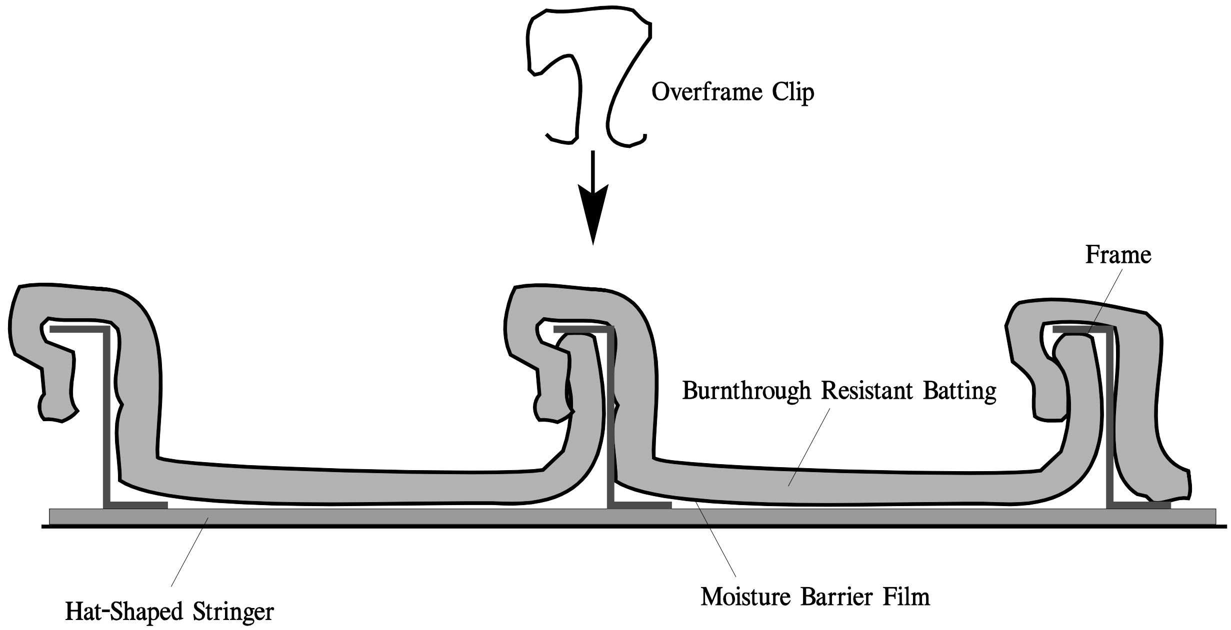

Figure 1-2. Integrated Capstrip/Field Blanket Replacement System

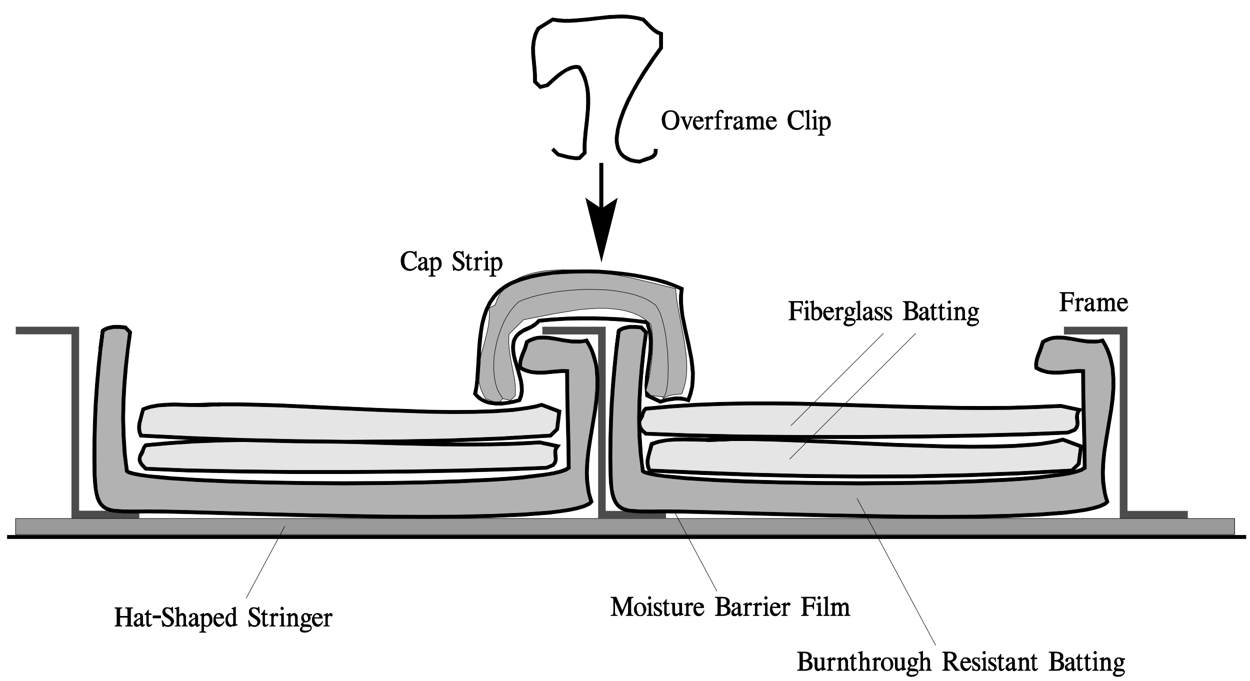

Figure 1-3. Combination Fiberglass/Replacement Batting System

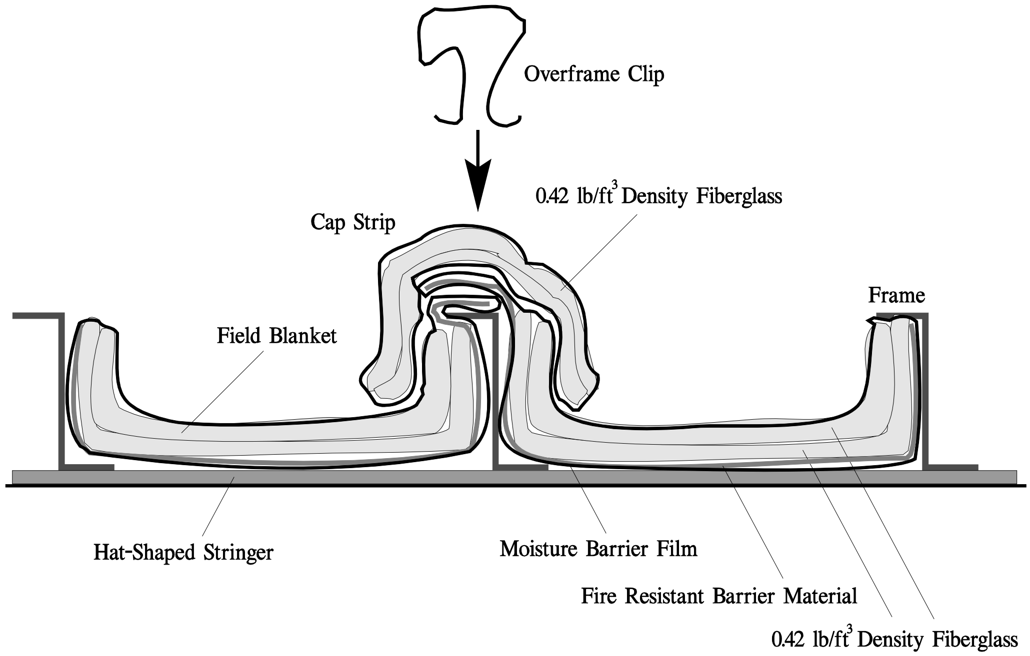

Figure 1-4. Barrier Material Used in Conjunction with Fiberglass

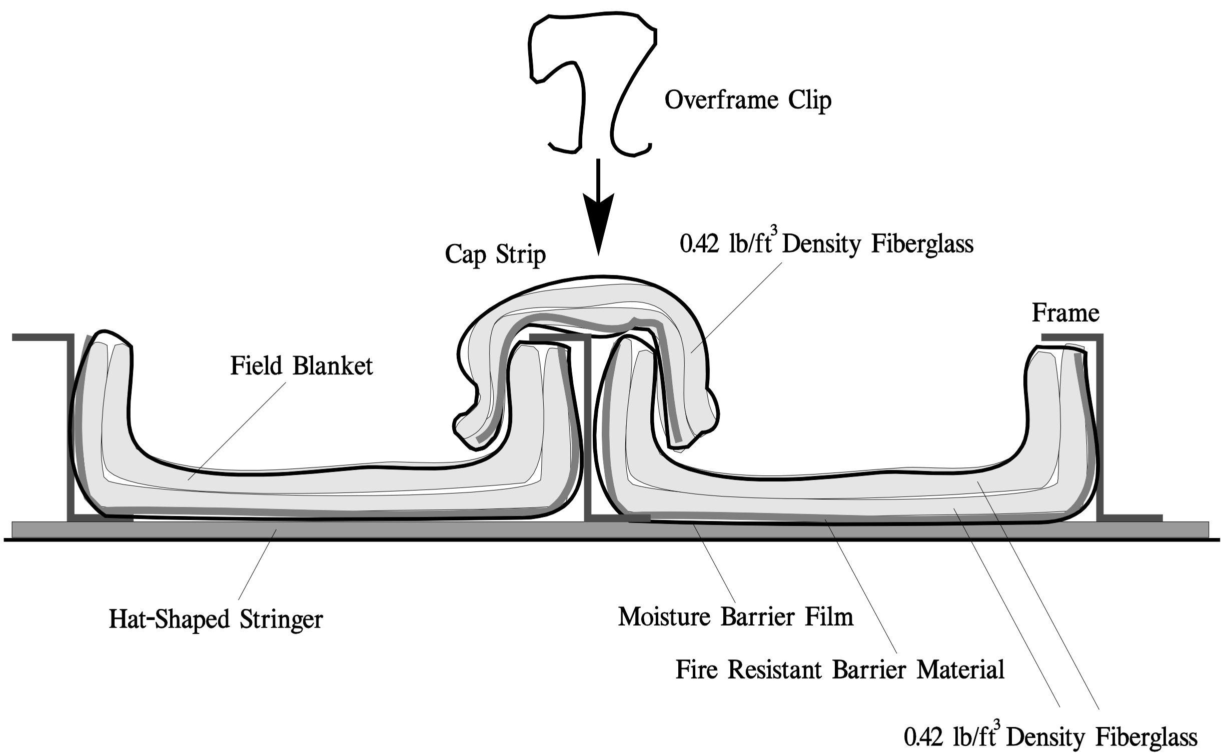

Figure 1-5. Barrier Material Used (including over frame) in Conjunction with Fiberglass

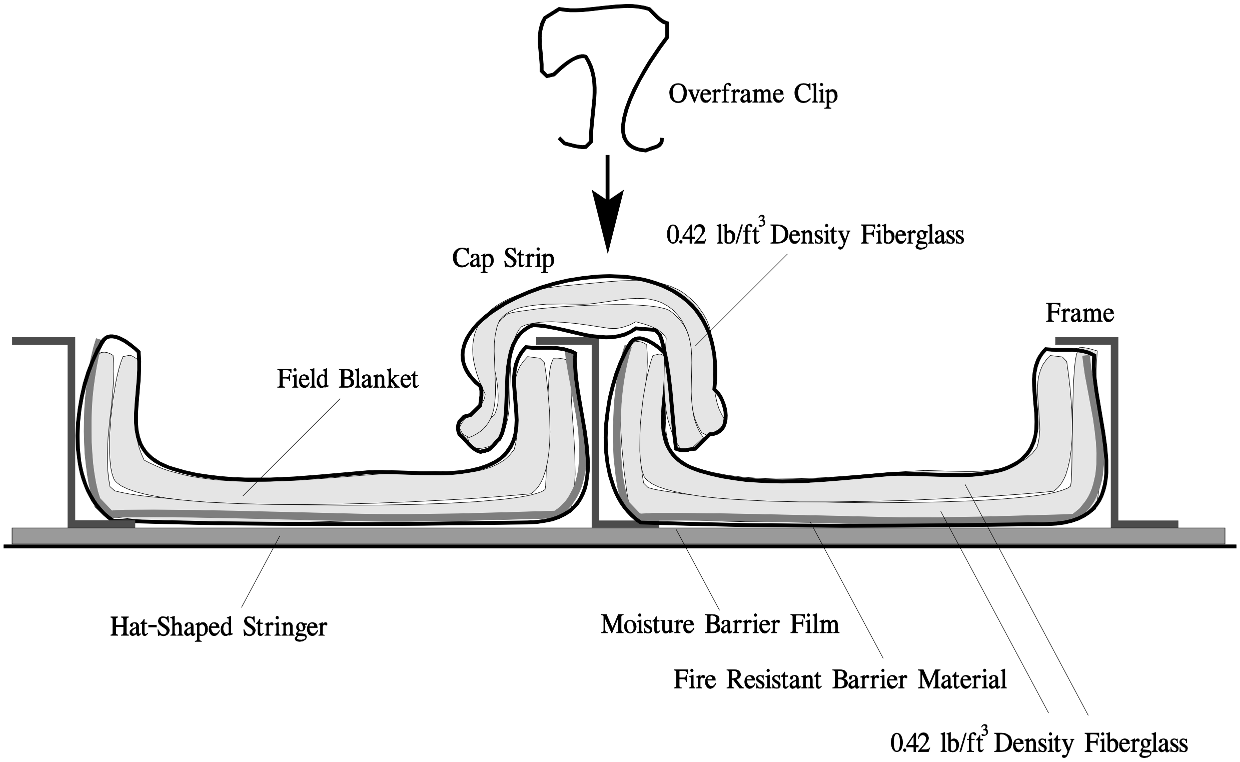

Figure 1-6. Barrier Material Used in Conjunction with Fiberglass

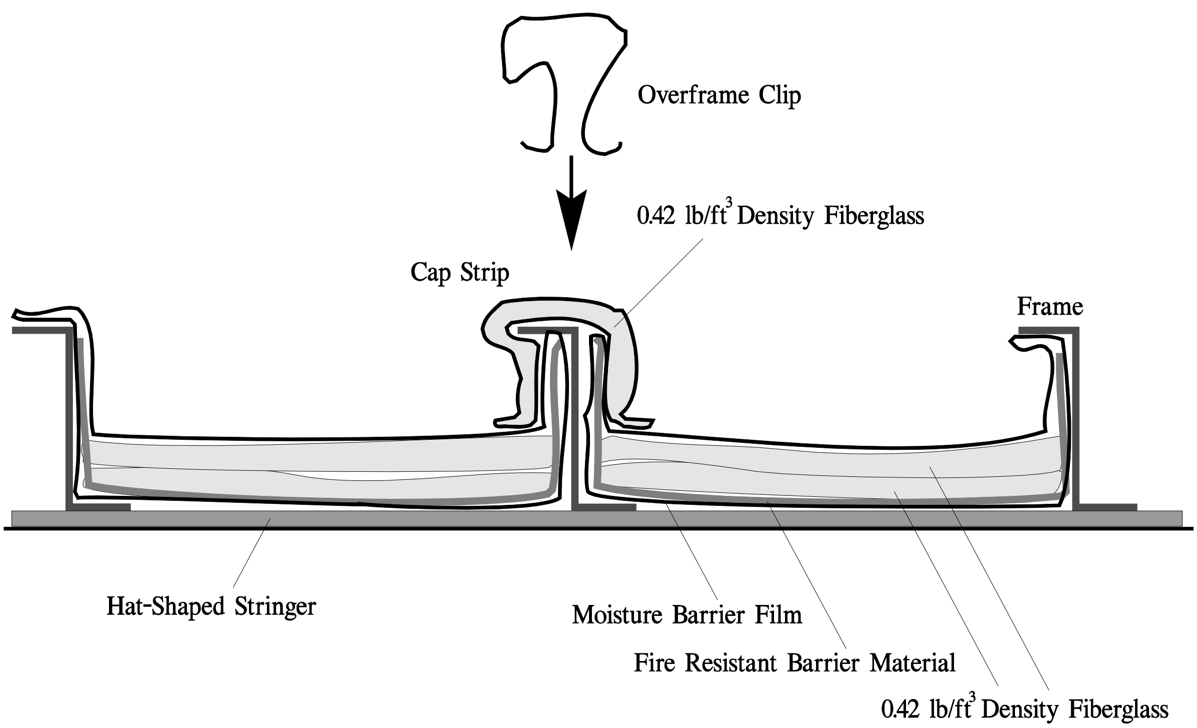

Figure 1-7. Barrier Material Used in Conjunction with Fiberglass

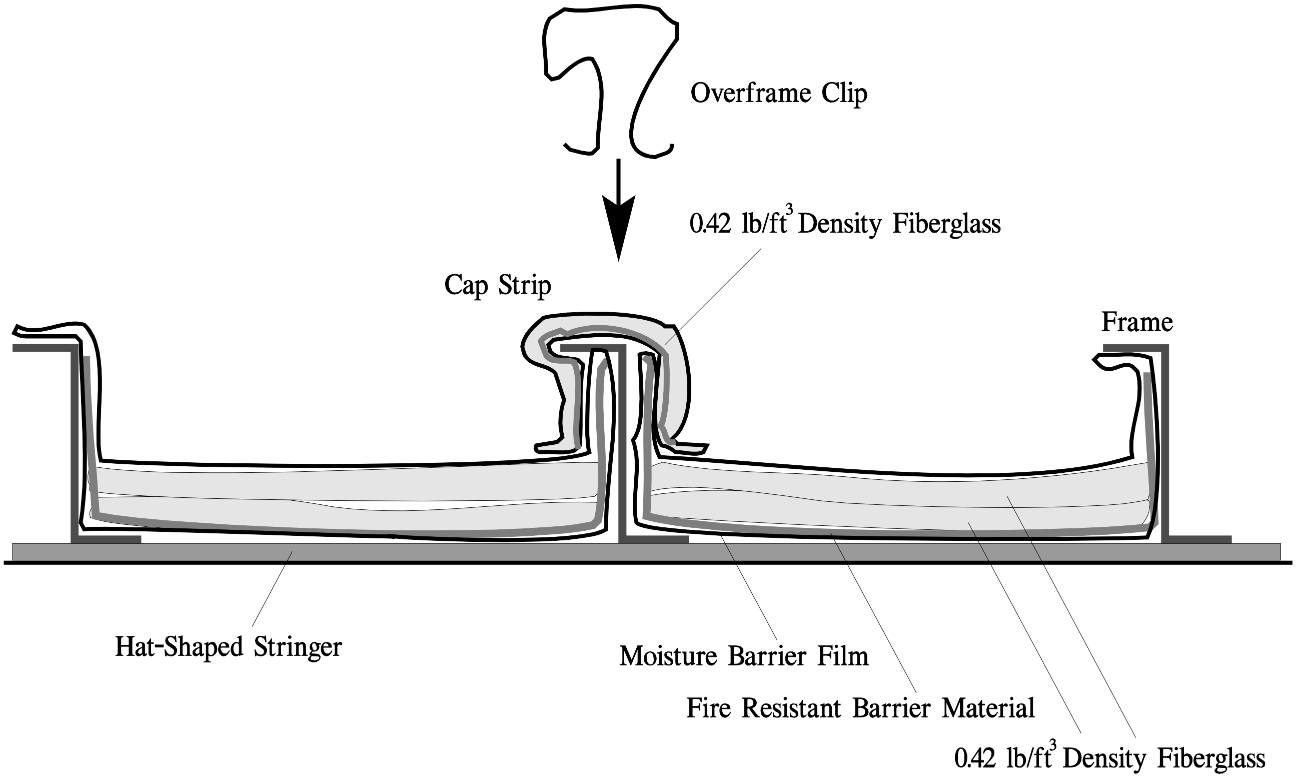

Figure 1-8. Barrier Material Used in Conjunction with Fiberglass

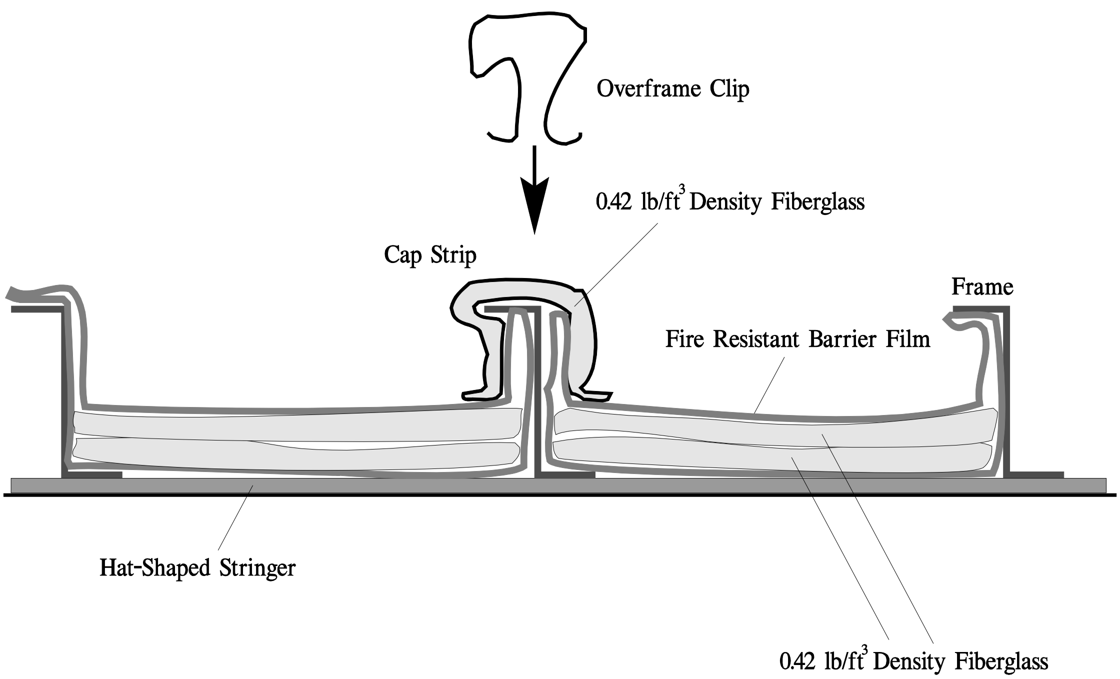

Figure 1-9. Encapsulating Film System Used in Conjunction with Fiberglass

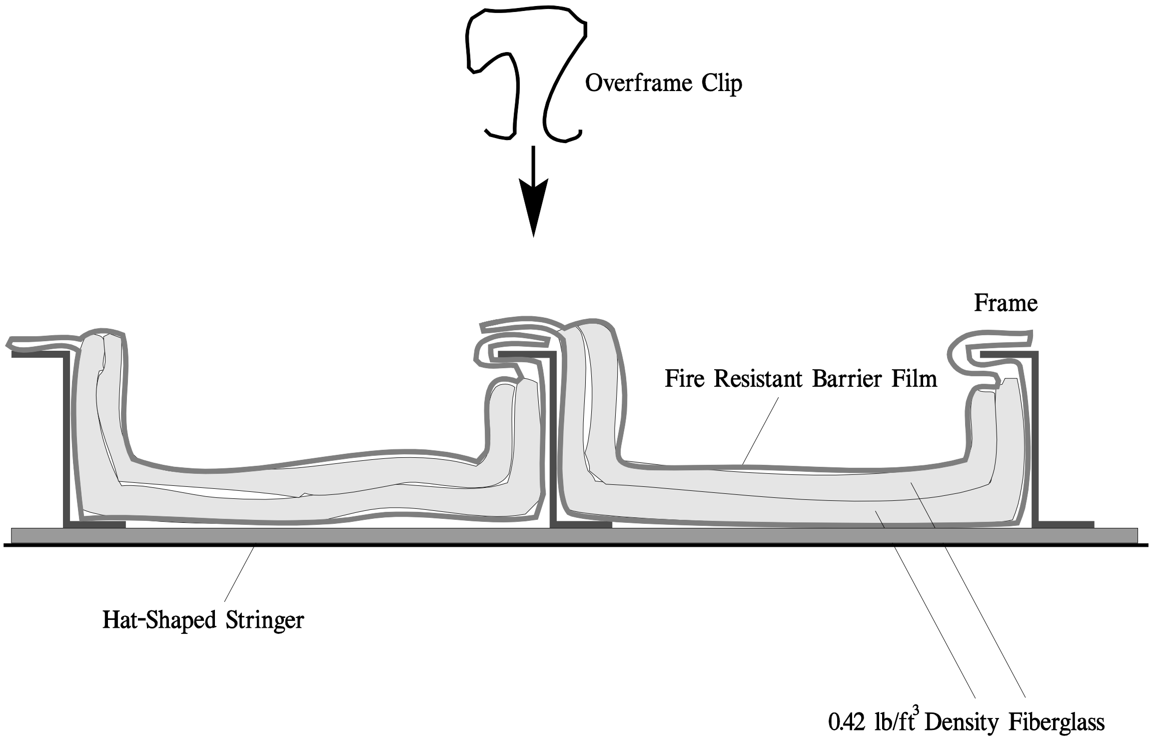

Figure 1-10. Encapsulating Film System Used in Conjunction with Fiberglass